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Lagrangian evaluation of convective activity in VHR
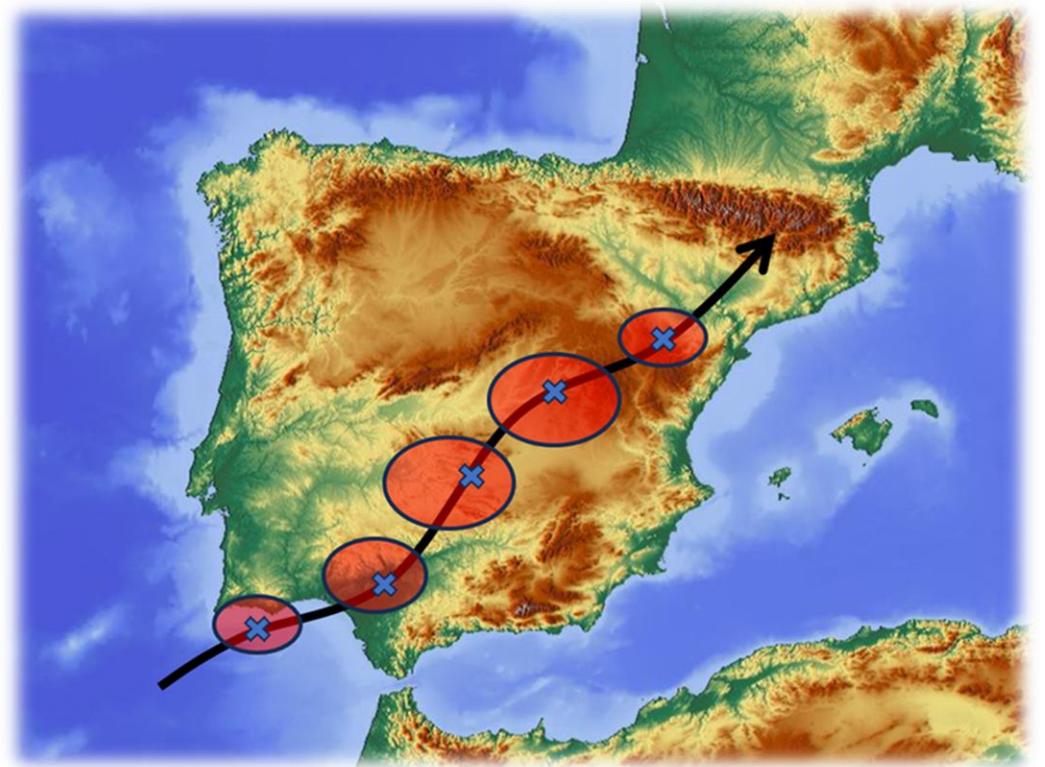
EWGLAM, 30-3 Oct 2024, Prague

Lagrangian evaluation of convective activity in VHR

- Thanks to the advent of VHR (sub-kilometric) NWP, we can start analysing specific convective activity features.

- At sub-kilometric resolutions, convective phenomena and features begin to be explicitly represented.

- Indeed, at VHR doubts arise regarding the use or not of shallow-convective squemes; a solution of scale-aware squeme has been proposed.

- Therefore, a window of opportunity for other kind of verification methods emerge -->
--> Lagrangian's point of view.
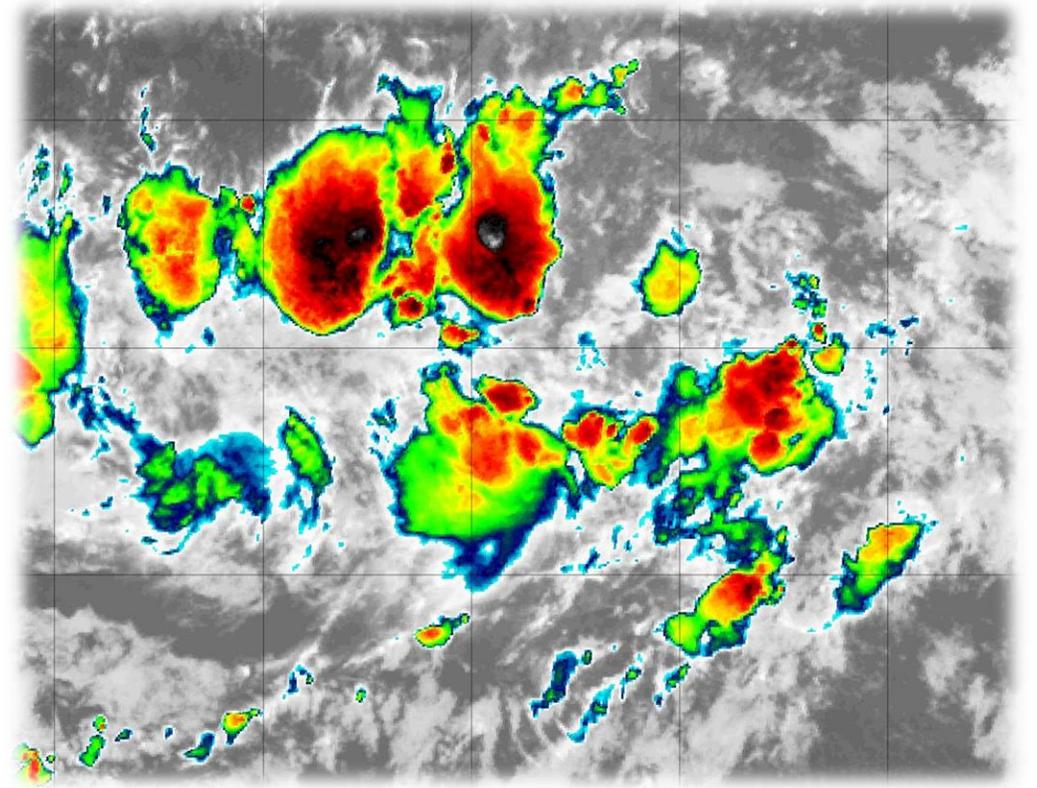
Lagrangian evaluation of convective activity in VHR

- Using a <u>tracking framework</u> for the analysis allows us to investigate the representation of convective clouds in the model.

- In this framework, <u>the development of individual clouds</u> is considered within the population of clouds into account, as opposed to relying on temporal and spatial statistics (Eulerian-based) of the cloud field.

- Using the same tracking framework for both model and observation data allows for a more <u>robust comparison</u> between them.

Lagrangian evaluation of convective activity in VHR

- It helps to:
  - Verify NWP simulations with satellite and radar data.
  - Evaluate statistics of convective activity, the frequency, the number, the behaviour of their life cycle, etc...
  - Convective storms.
  - Modes of convective storms:
    - Convective storms with high precipitation rate (BTs+precip).
    - Convective storms with high reflectivity (BTs+radar reflec).
    - Convective storms with high lightning activity (BTs+lightning).
    - Supercells, MCSs, MCCs, squall lines, derechos.
  - Convective initiation.

Lagrangian evaluation of convective activity in VHR

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  - **Convective initiation.**

Lagrangian evaluation of convective activity in VHR

- Methods for cloud tracking are gaining importance in the analysis of model simulations.

- Here we use the TOBAC method --> Tracking and Object-Based Analysis of Clouds:

| Article | Assets | Peer review | Metrics | Related articles |

Methods for assessment of models   30 Oct 2019

tobac 1.2: towards a flexible framework for tracking and analysis of clouds in diverse datasets

Max Heikenfeld[1], Peter J. Marinescu[2], Matthew Christensen[1], Duncan Watson-Parris[1], Fabian Senf[3], Susan C. van den Heever[2], and Philip Stier[1]

[1]Atmospheric, Oceanic & Planetary Physics, Department of Physics, University of Oxford, Oxford, UK
[2]Department of Atmospheric Sciences, Colorado State University, Fort Collins, USA
[3]Leibniz Institute for Tropospheric Research, Leipzig, Germany

Correspondence: Philip Stier (philip.stier@physics.ox.ac.uk)

Lagrangian evaluation of convective activity in VHR
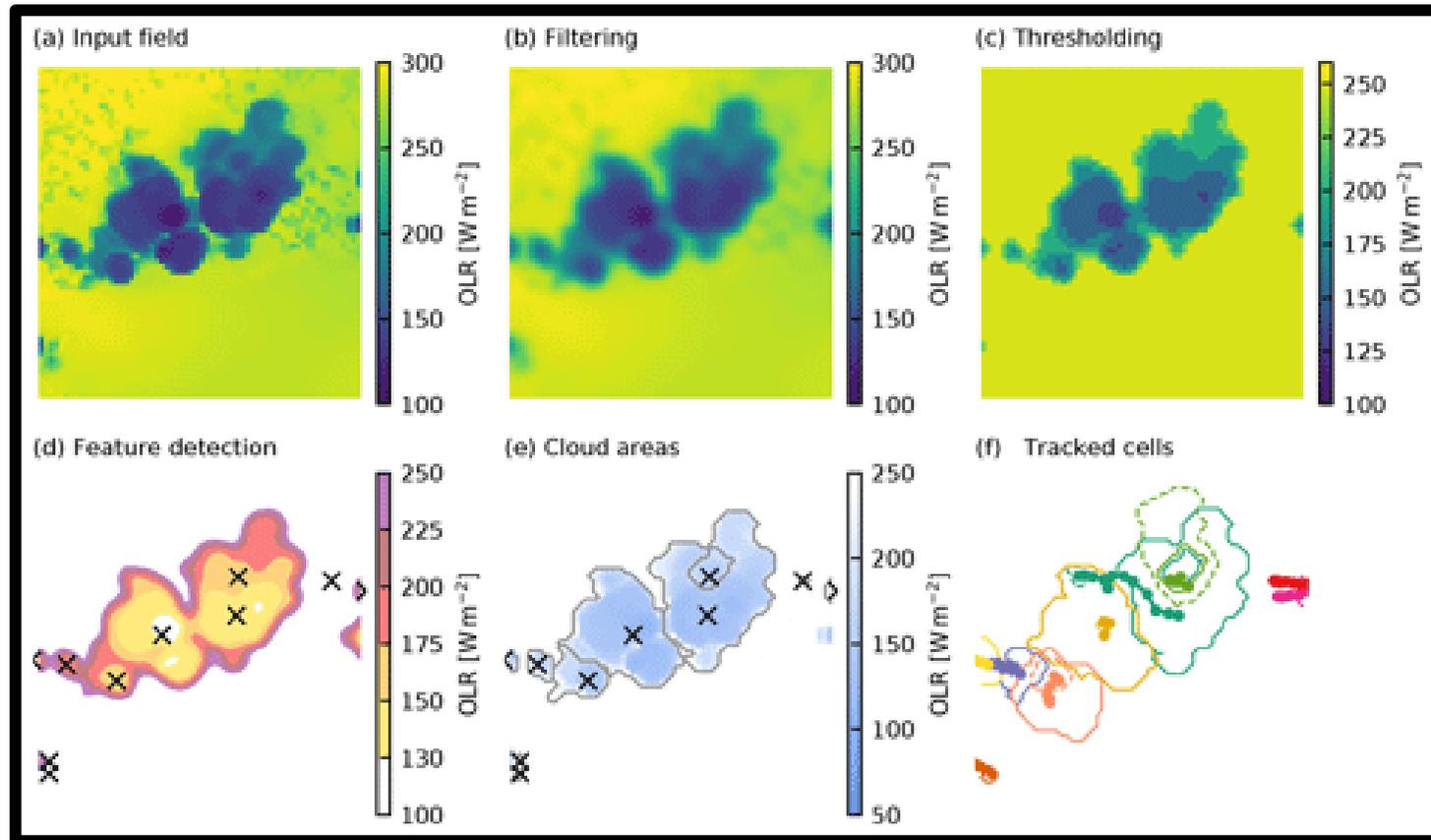
🗗 Edit on GitHub

tobac - Tracking and Object-Based Analysis of Clouds

- tobac is a Python package to identify, track and analyze clouds in different types of gridded datasets, such as 3D model output from cloud-resolving model simulations or 2D data from satellite retrievals.

- The software is set up in a modular way to include different algorithms for feature identification, tracking, and analyses.

- tobac is also input variable agnostic and doesn't rely on specific input variables, nor a specific grid to work.

- An associated volume can then be determined using these features with a separate (or identical) time-varying 2D or 3D field and a threshold.

- The identified objects are linked into consistent trajectories representing the cloud over its lifecycle in the tracking step.

- Analysis and visualization methods are provided in a convenient way to use and display the tracking results.

tobac sidebar navigation:

- 🏠 tobac — latest
- Search docs
- BASIC INFORMATION
  - Installation
  - Data input
  - Analysis
  - Plotting
  - Handling Large Datasets
  - Example notebooks
  - Refereed Publications
- FEATURE DETECTION
  - Feature Detection Basics
  - Threshold Feature Detection Parameters
  - Feature Detection Parameter Examples
  - Feature Detection Output
- SEGMENTATION
  - Segmentation
  - Watershedding Segmentation Parameters
  - Segmentation Output
  - Features without segmented areas
- TRACKING
  - Linking
  - Tracking Output

Figure panels:
a) Input data — + new features, + old features, × deleted features, + final features
b) Threshold 1
c) Intermediate features 1
d) Threshold 2
e) Intermediate features 2
f) Threshold 3
g) Intermediate features 3
h) Final set of features

- tobac - Tracking and Object-Based Analysis of Clouds:

- Verification of convective initiation (CI) with satellite and reflectivity data:

Editorial Type: Article

Article Type: Research Article

Evaluating Convective Initiation in High-Resolution Numerical Weather Prediction Models Using *GOES-16* Infrared Brightness Temperatures

David S. Henderson, Jason A. Otkin, and John R. Mecikalski

Online Publication: 31 Mar 2021

Print Publication: 01 Apr 2021

DOI: https://doi.org/10.1175/MWR-D-20-0272.1

Page(s): 1153–1172

Article History   Download PDF   © Get Permissions

• Verification of convective initiation (CI) with satellite and radar data:
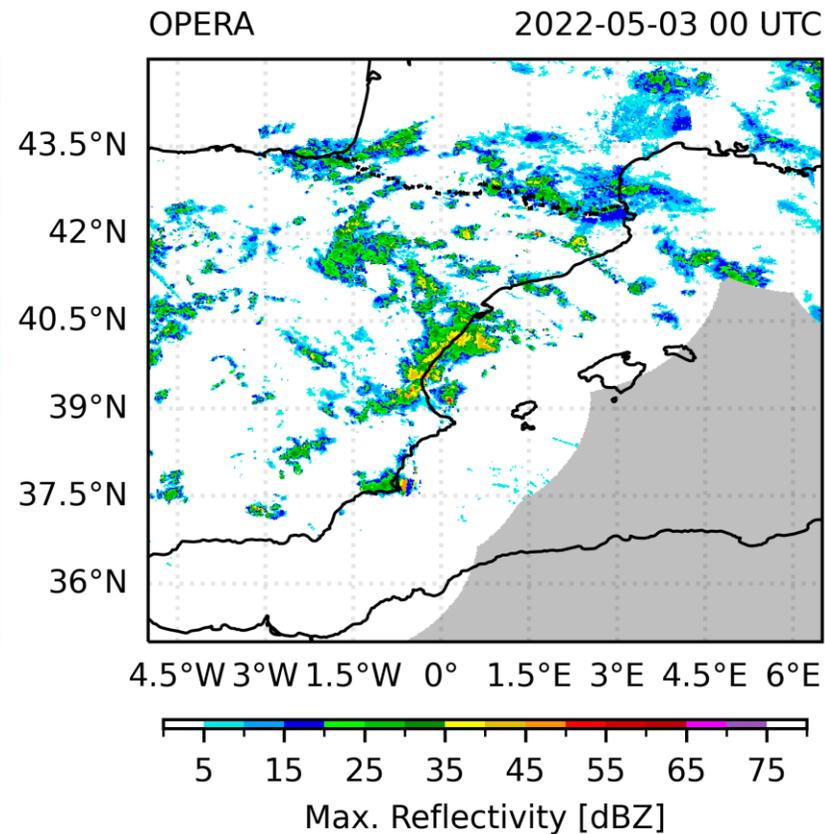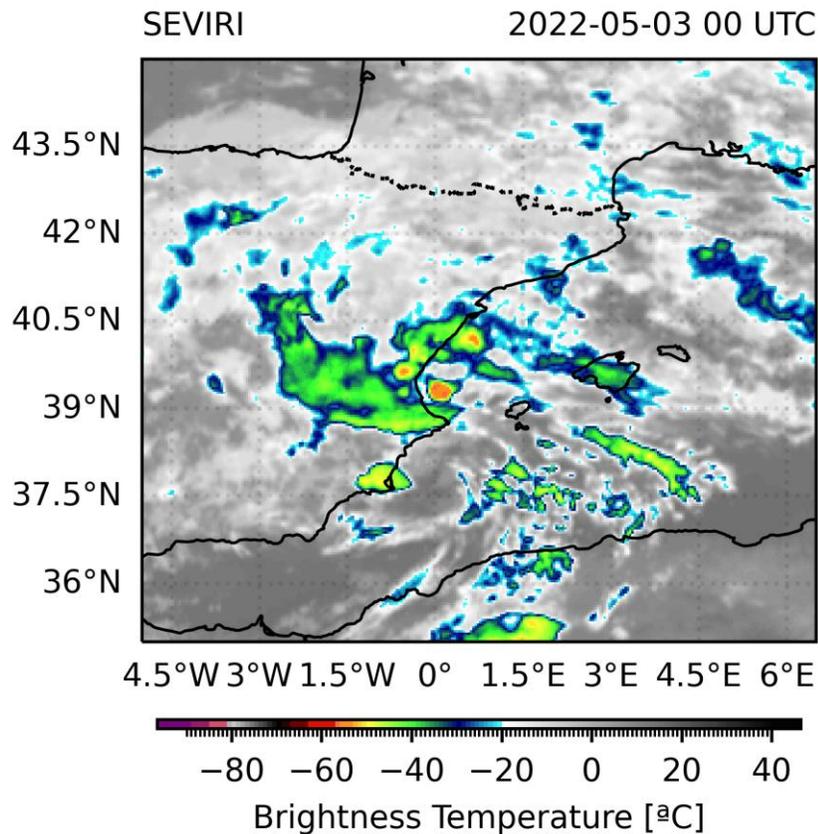
Tracked cells animation:
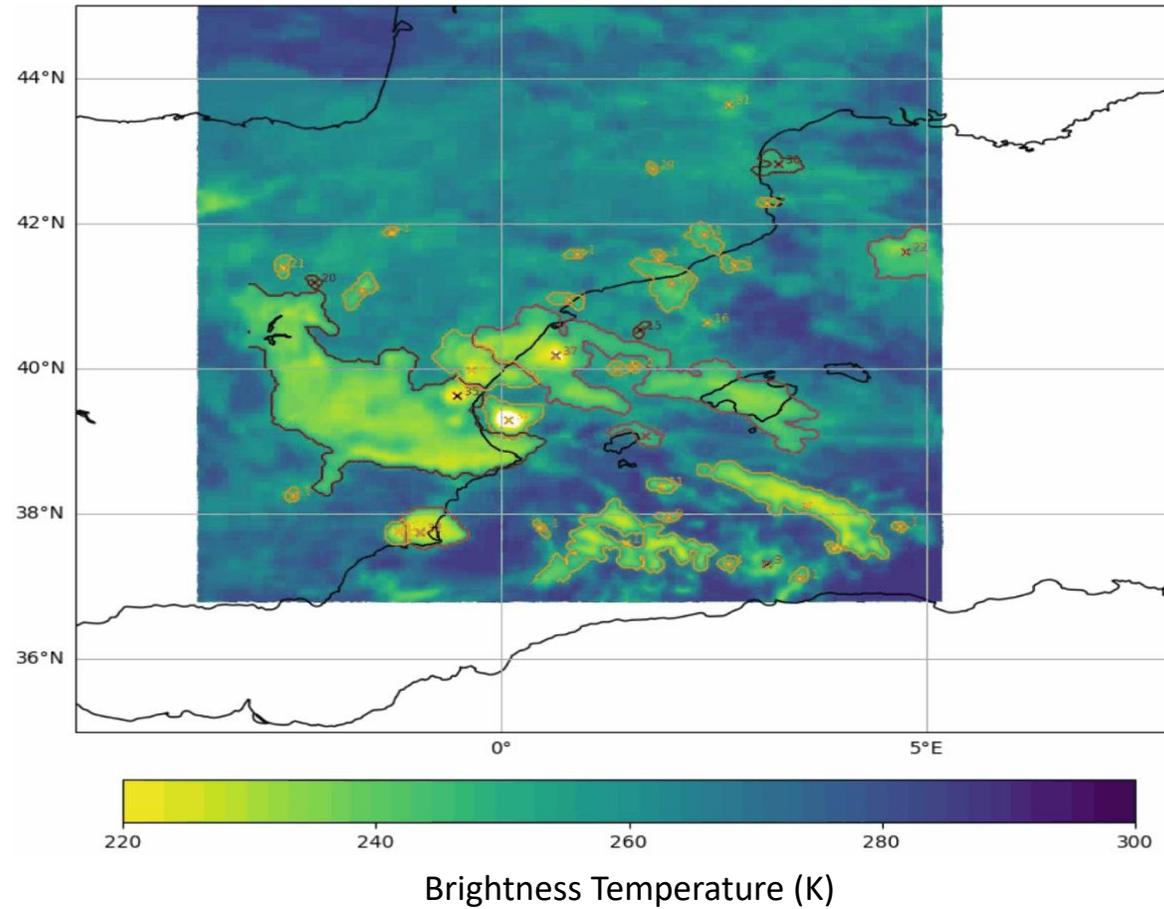
Brightness Temperature (K)

- Tracked cell (nº 392) example:
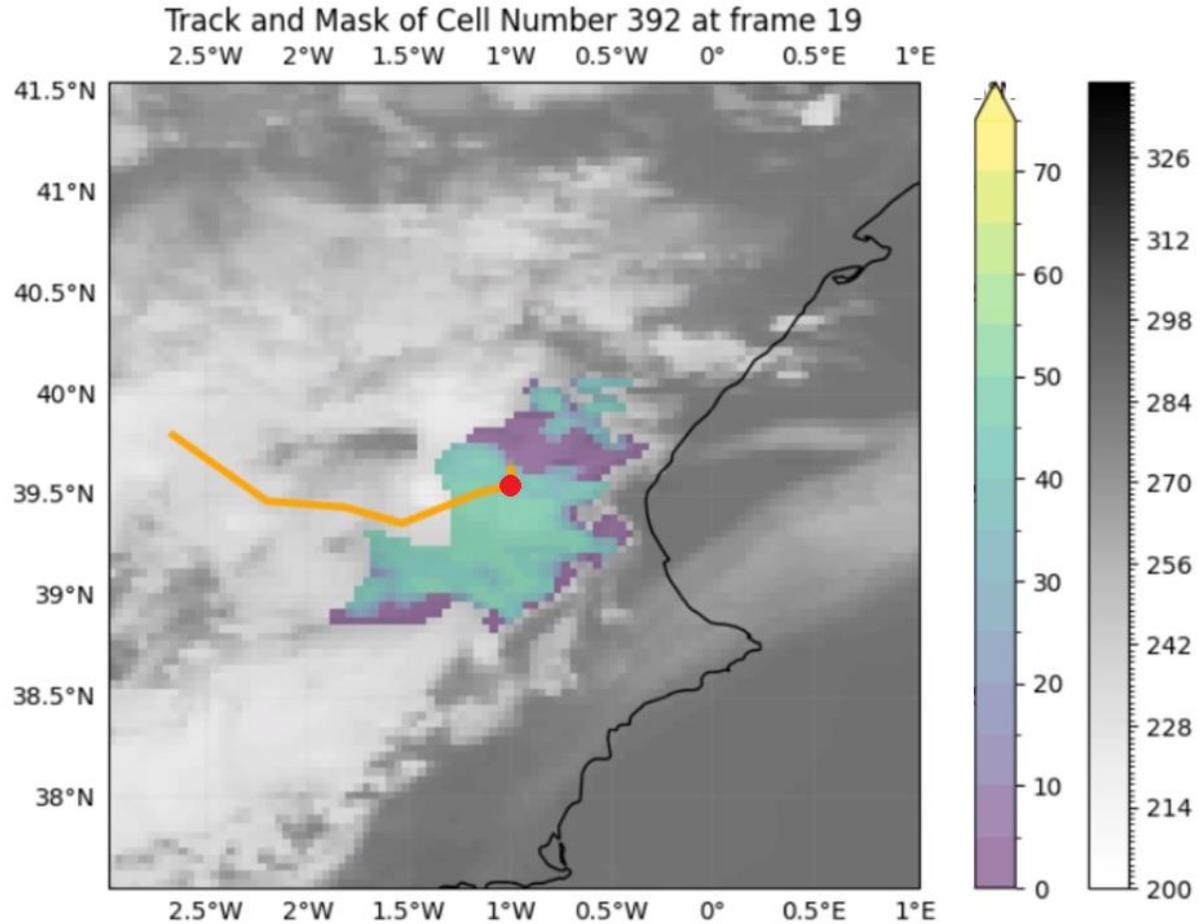
brightness temperature (K; grey shading)

reflectivity (colour shading) plotted over the cell assigned domain

All tracked cells

2.5 km

```
AIB_46h1_de2
Cell number / nº time steps
292         8
287         7
392         7
67          7

    . . .

243         2
244         2
246         2
248         2
252         2
Name: cell, Length: 246,
```

500 m

```
VAL500m_46h1_de2
Cell number / nº time steps
173        17
39         11
280        11
177        10

    . . .

148         2
316         2
149         2
154         2
157         2
Name: cell, Length: 238,
```

OBS

```
OBS
Cell number / nº time steps
202        10
150         9
196         9
80          8

    . . .

84          2
81          2
76          2
75          2
72          2
Name: cell, Length: 132,
```

- All tracked and filtered (CI) convective cells:
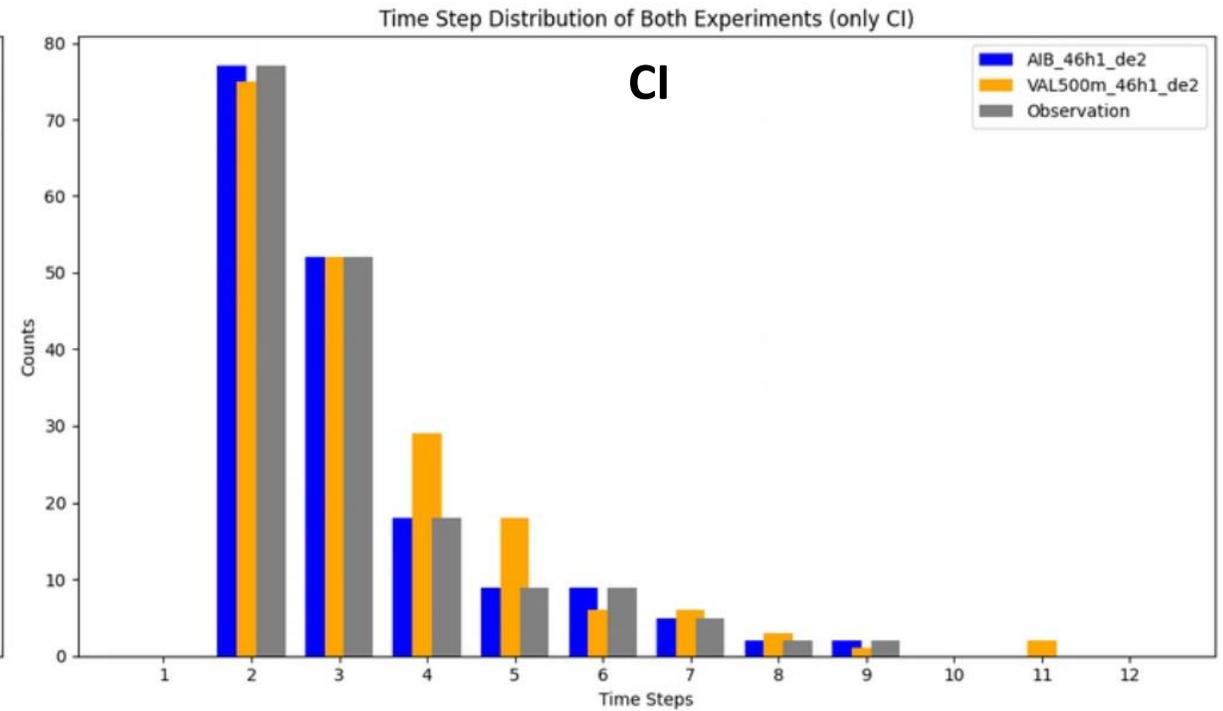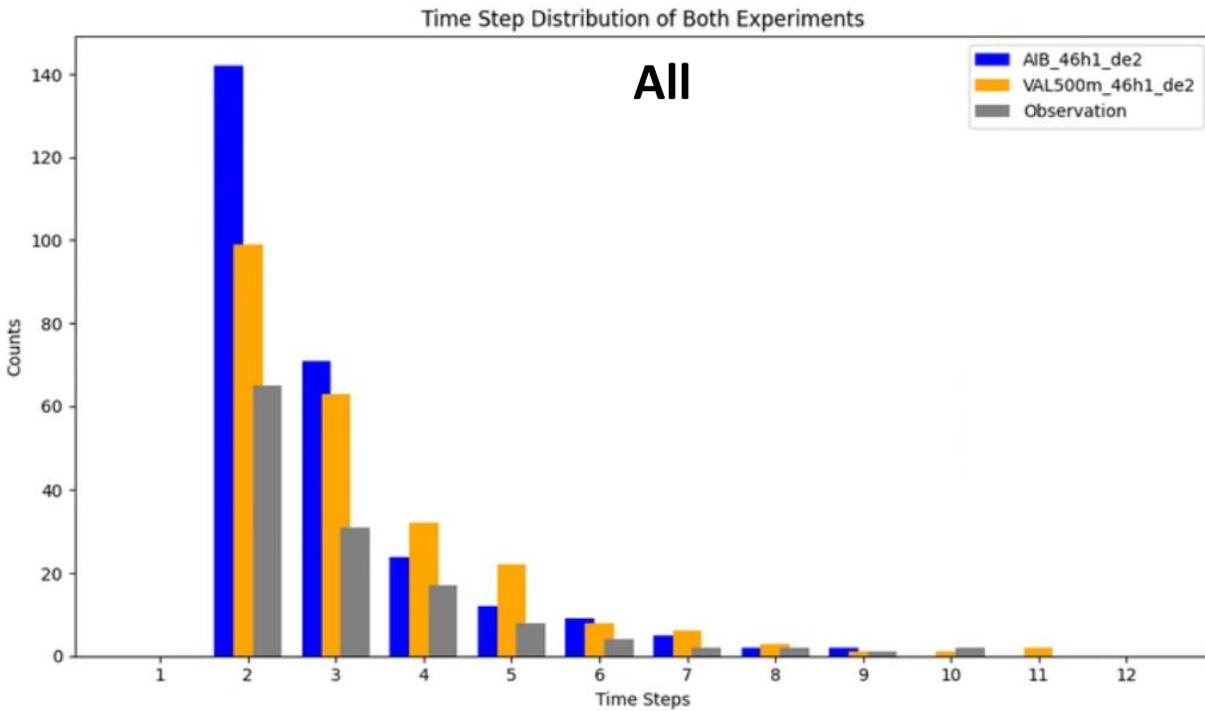
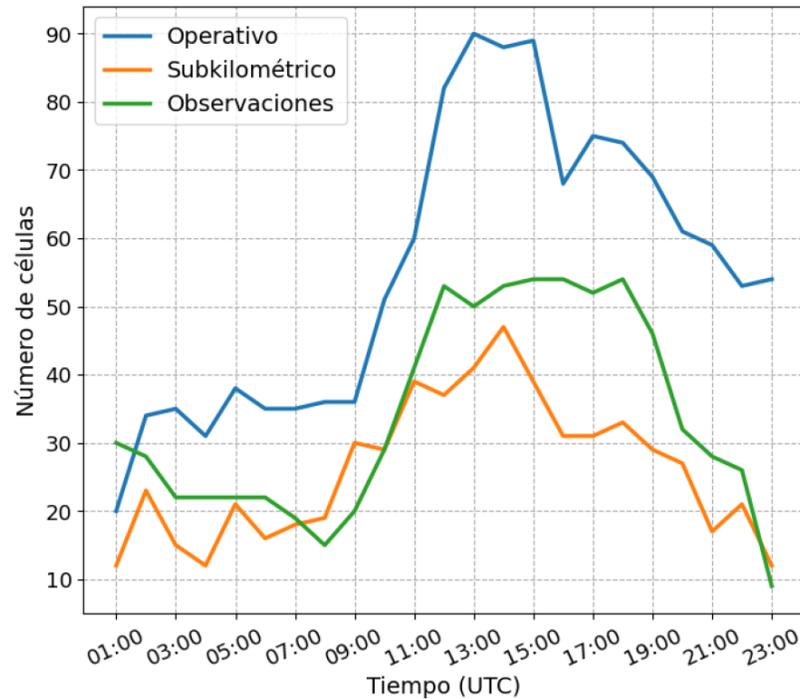CI occurs when a refl > 35 dBZ within cell domain

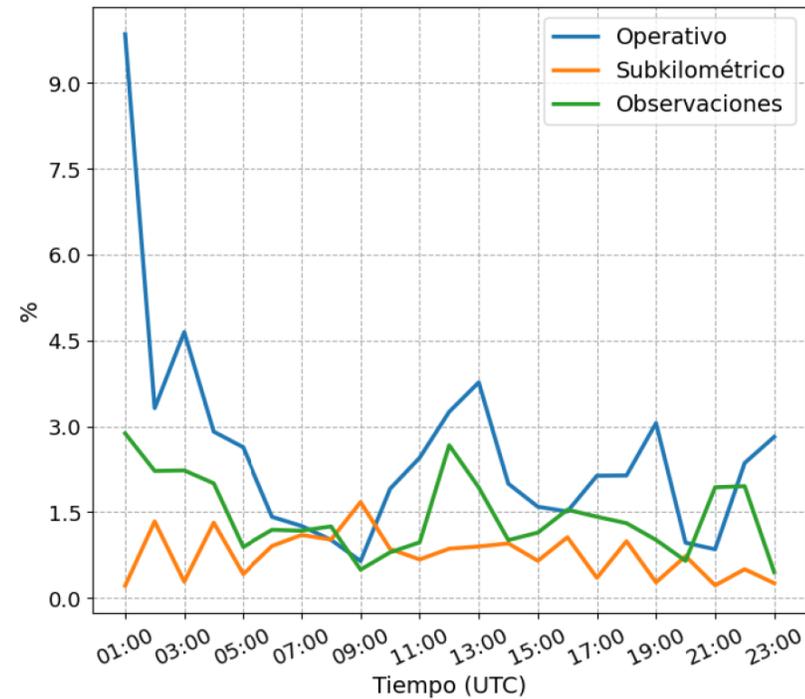- All tracked and filtered (CI) convective cells:
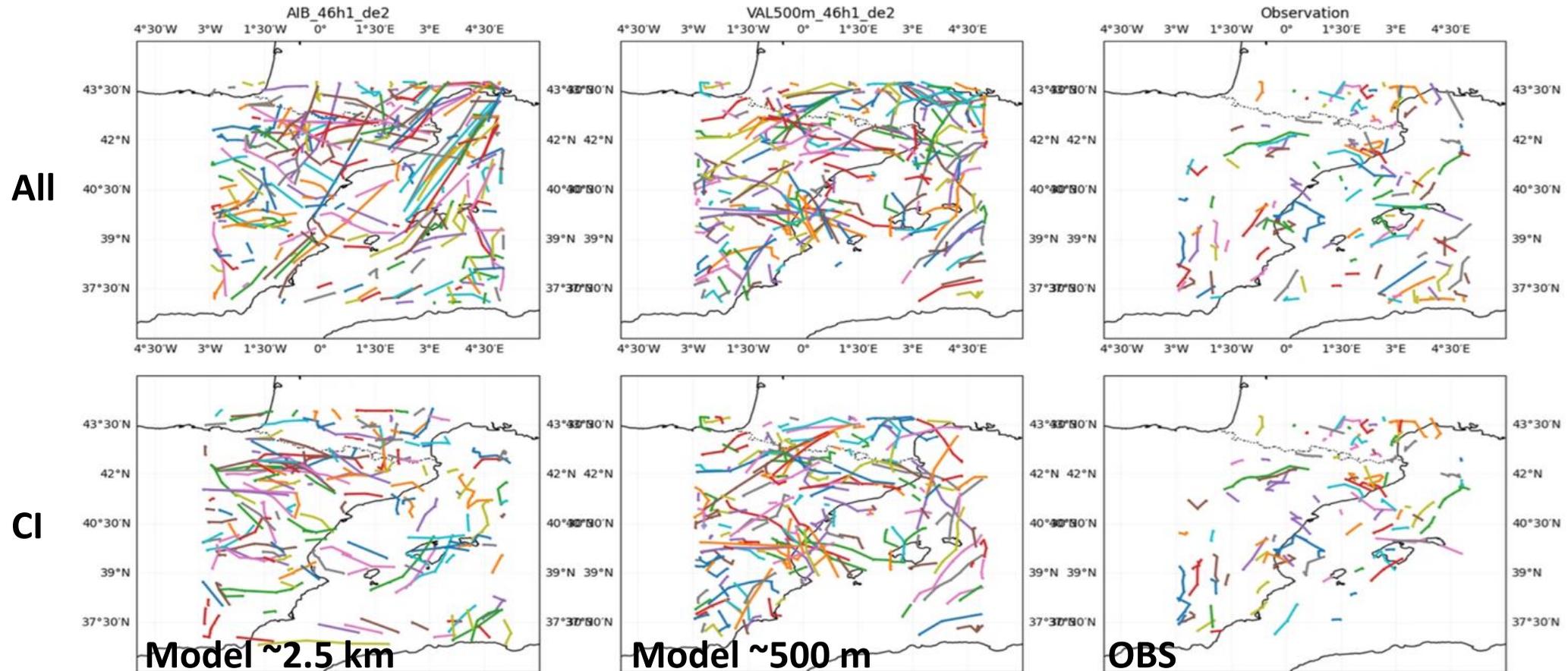
Lagrangian evaluation of convective activity in VHR - RESULTS

*Not to derive scientific conclusions yet

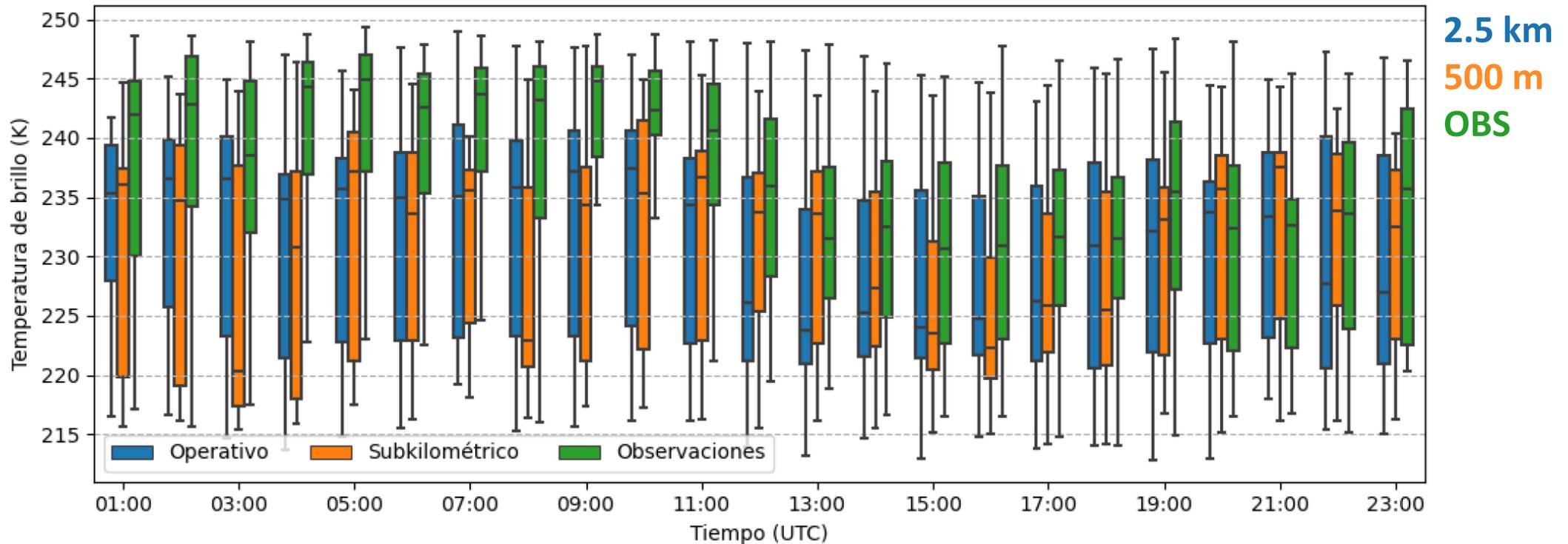**nº of cells with CI**

% of sky covered by cells with CI

2.5 km
500 m
OBS

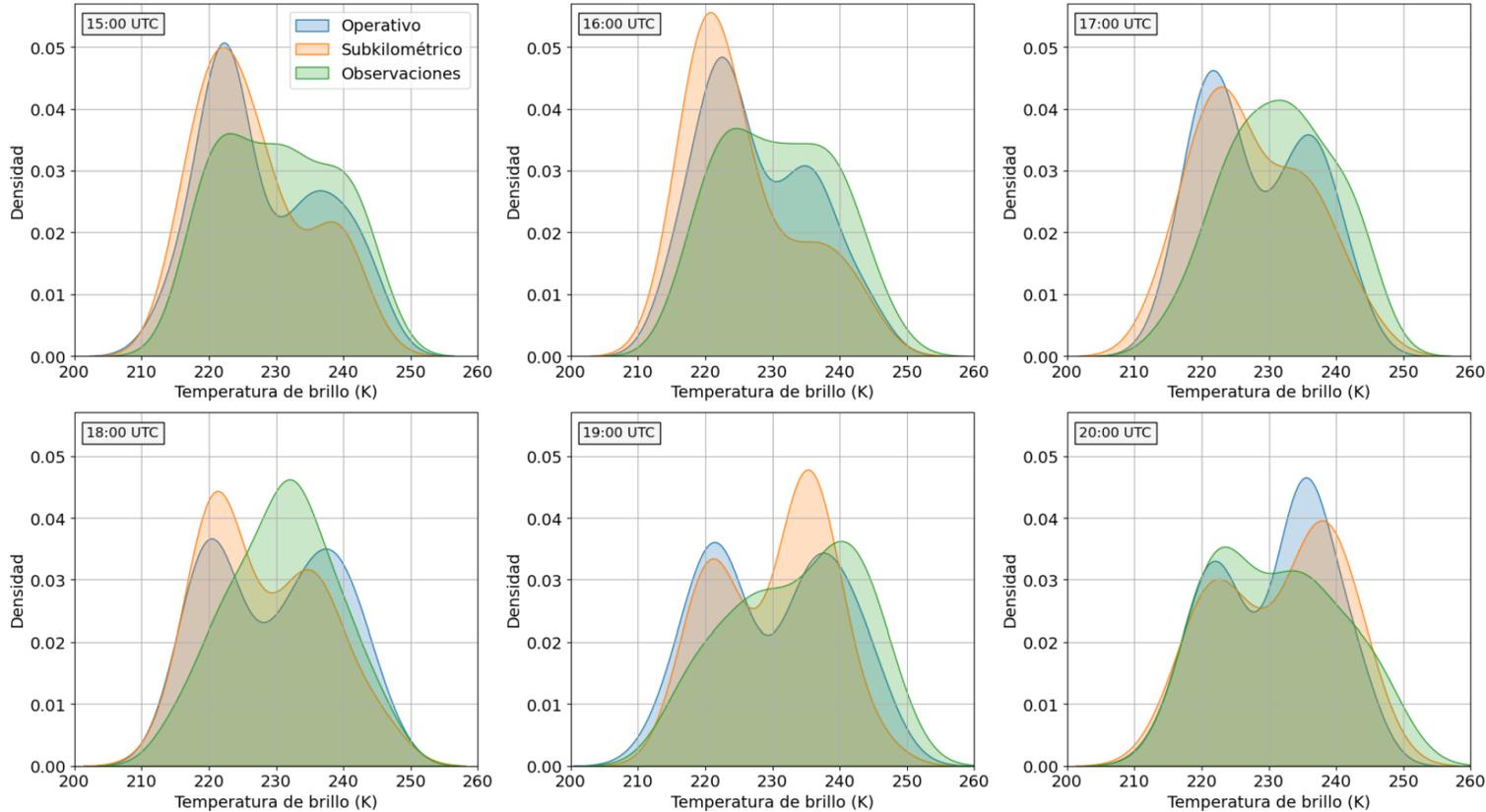# Lagrangian evaluation of convective activity in VHR - RESULTS

*Not to derive scientific conclusions yet

Minimum BT for cells with CI at each hour

2.5 km
500 m
OBS

Lagrangian evaluation of convective activity in VHR - RESULTS

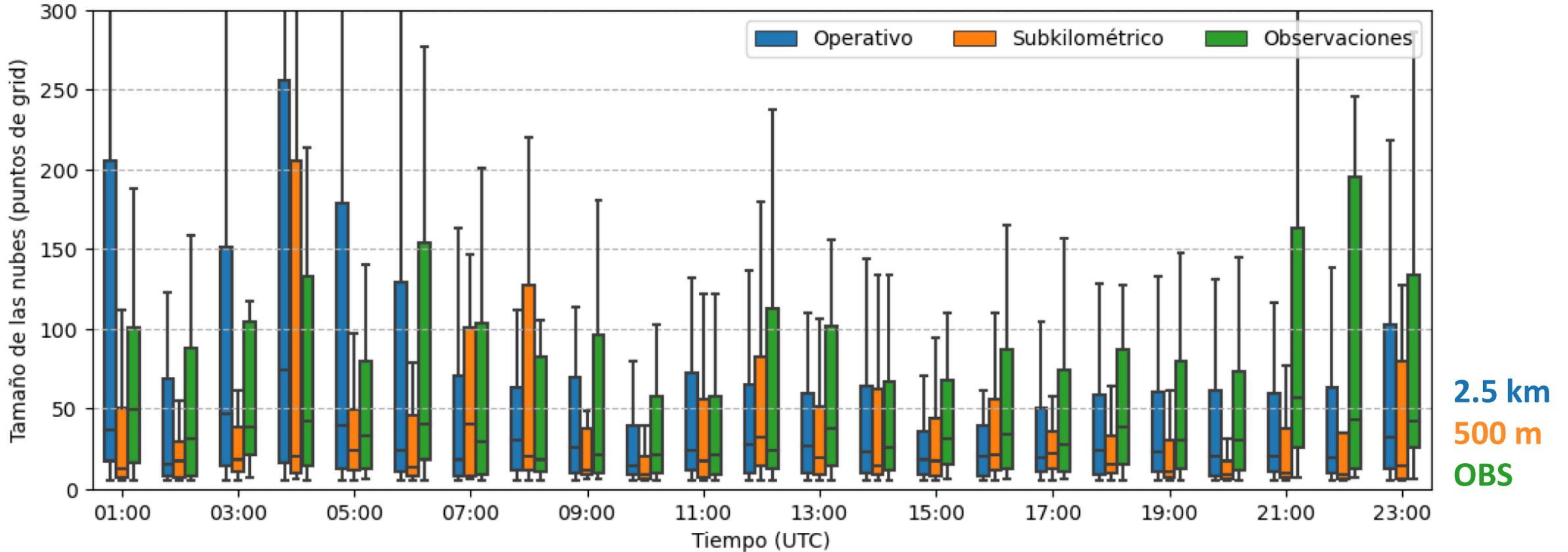*Not to derive scientific conclusions yet

Probability density functions for BT within cells with CI domain at different time step

2.5 km
500 m
OBS

Lagrangian evaluation of convective activity in VHR - RESULTS
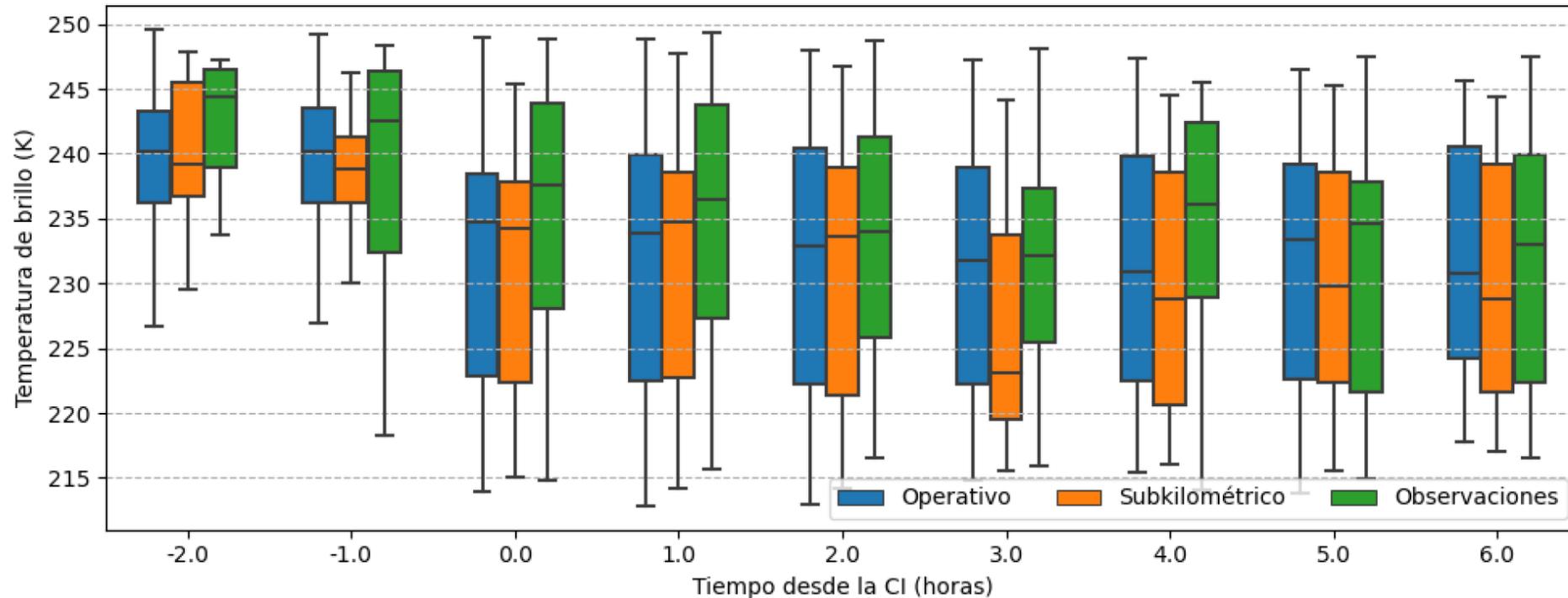
*Not to derive scientific conclusions yet

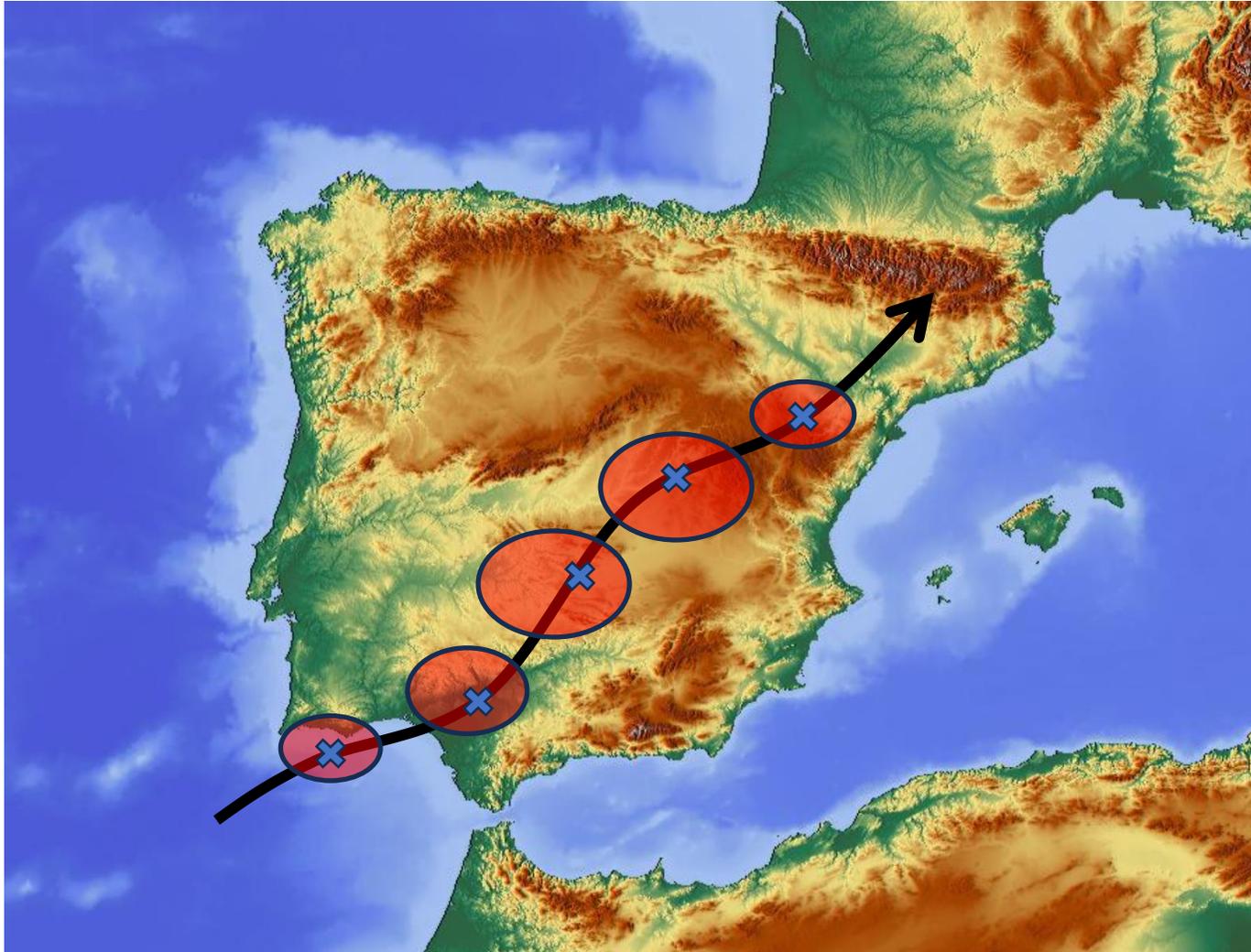**CI cell size (nº of grid points)**

Lagrangian evaluation of convective activity in VHR – RESULTS

*Not to derive scientific conclusions yet

Temporal evolution of min BT within CI cell domain
**(time with respect CI start)**

# Lagrangian evaluation of convective activity in VHR – SUMMARY

- Test of a could tracking methodology to evaluate convective activity in models, focused on convective initiation.

- The method is able to study and characterize convective activity.

- The method is useful for evaluating convective activity behaviour and verify from object and Lagrangian point of view.

Lagrangian evaluation of convective activity in VHR – FUTURE WORK
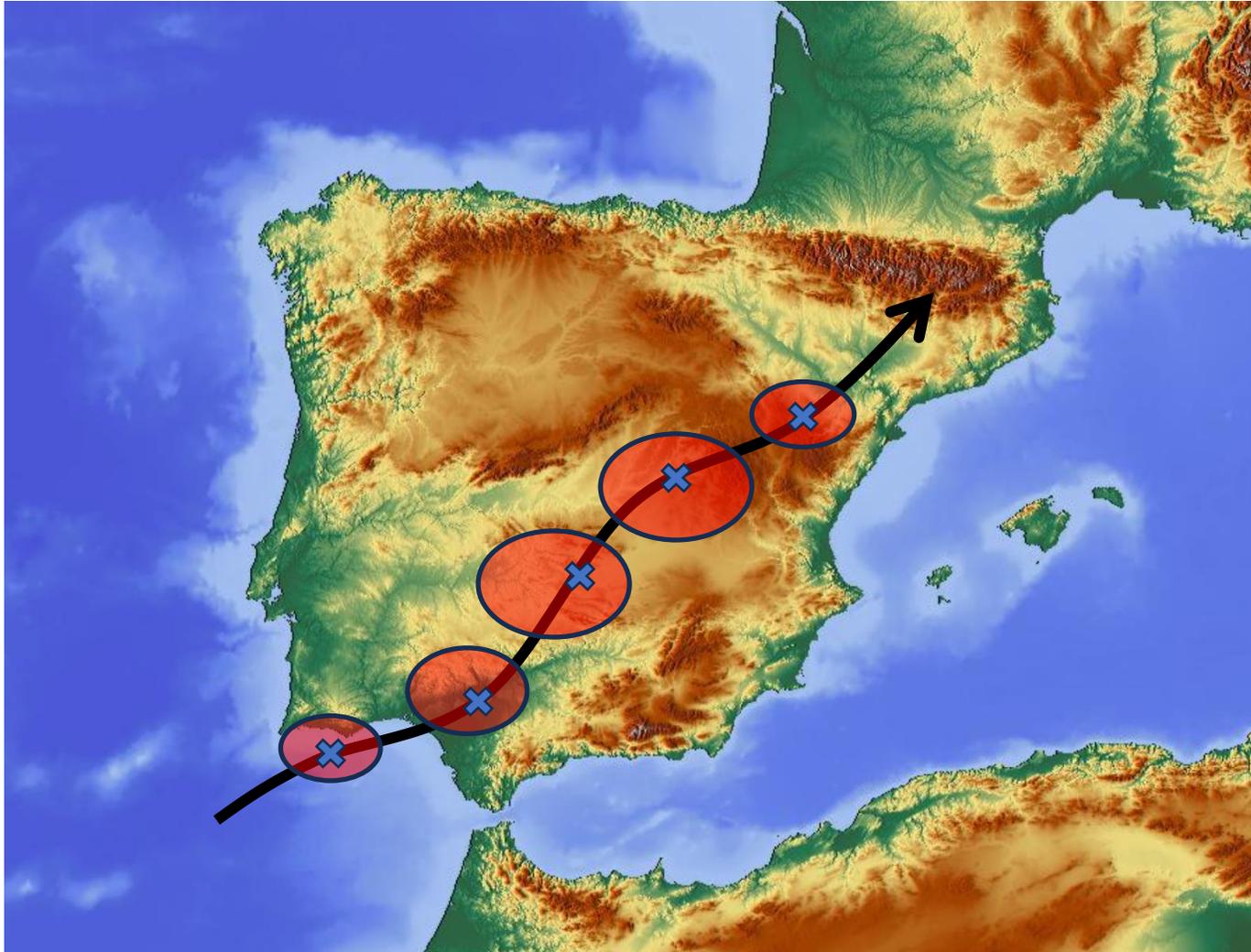
- Further testing of parameters associated with the tracker to get reliable convective cells.

- Test shallow convective schemes with this methodology.

- Test DDH (tool for physics understanding) following the cells.

- Analyse other metrics and convective modes.
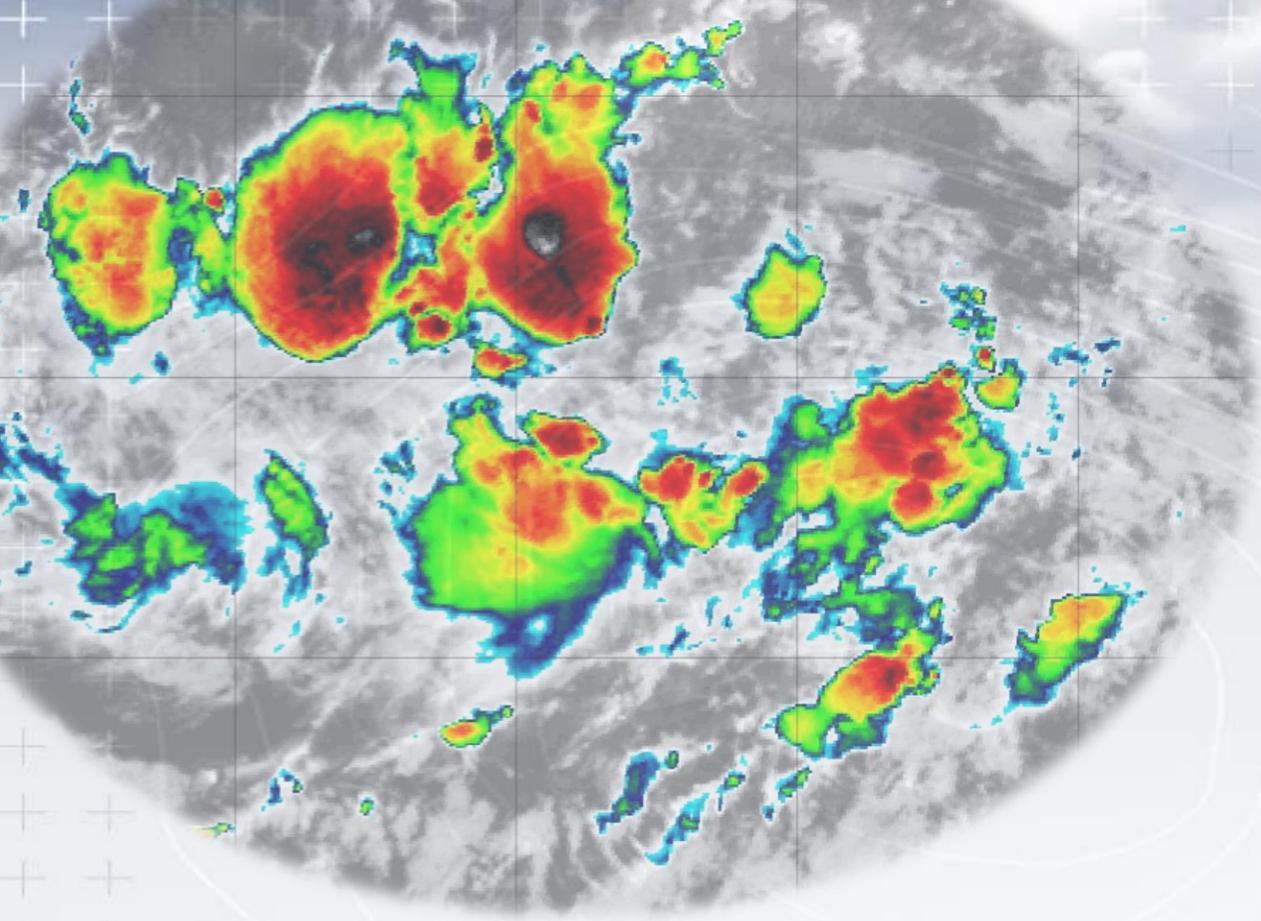
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Thanks for your attention